What is claimed is:

1. An approximation method for a series expansion of an input function with a finite number of terms N to minimize an approximation error, comprising:

expanding the input function in Taylor series up to an (N-1)-th term to obtain a first expansion result;

expanding the input function in Taylor series up to an N-th term to obtain a second expansion result;

multiplying the first expansion result by a predetermined weight α to obtain a multiplication result;

combining the multiplication result and the second expansion result to obtain a combined result; and

dividing the combined result by($\alpha + 1$).

2. The method of claim 1, wherein α is greater than 0 and no greater than 1.

3. An approximation method for a series expansion of an input function with a finite number of terms N to minimize an approximation error, comprising:

expanding the input function in Taylor series up to an (N-1)-th term to obtain an expansion result;

multiplying an N-th term of the expansion result by a predetermined weight value to obtain a multiplication result; and

combining the expansion result and the multiplication result to obtain an approximation function f for the series expansion of the input function.

4. The method of claim 3, wherein the predetermined weight value is $\frac{(-1)^N}{(\alpha+1)}$, for $0<\alpha\leq 1$.

5. The method of claim 4, wherein a value α obtained for a corresponding respective N is selected so as to minimize a maximum of the approximation error.

6. The method of claim 4, wherein the value of α is obtained by:

(a) selecting a minimum input in a given input x area;

(b) calculating the approximation function f for the input with the finite number of terms N;

(c) obtaining and storing an error $|E_{N,x}|$ by subtracting the approximation function f from a nominal function value of the input x;

(d) determining whether the input x has reached a maximum value in the given input x area;

(e) adding a predetermined increment ξ to the input x if the input x has not yet reached the maximum value, and repeating steps (b), (c) and (d);

(f) selecting a maximum error value among all the stored errors of $|E_{N,x}|$ for all inputs when

x has reached a maximum value; and

(g) searching the value α to minimize the maximum error value, and storing the value α as the weight value for a corresponding N.

7. The method of claim 3, wherein the value of α is obtained by:

(a) selecting a minimum input in a given input x area;

(b) calculating the approximation function f for the input with the finite number of terms N;

(c) obtaining and storing an error $|E_{N,x}|$ by subtracting the approximation function f from a nominal function value of the input x;

(d) determining whether the input x has reached a maximum value in the given input x area;

(e) adding a predetermined increment ξ to the input x if the input x has not yet reached the maximum value, and repeating steps (b), (c) and (d);

(f) selecting a maximum error value among all the stored errors of $|E_{N,x}|$ for all inputs when x has reached a maximum value; and

(g) searching the value α to minimize the maximum error value, and storing the value α as the weight value for a corresponding N.

8. An approximation method for a series expansion of an input function with a finite number of terms N to minimize an approximation error, comprising:

dividing a whole input area into several predetermined sub-intervals:

expanding the input function in Taylor series up to an (N-1)-th term in each of the sub-intervals to obtain a series expansion for each sub-interval;

multiplying an N-th term of the series expansion of the input function with a predetermined first weight for inputs on a left side of a center for said each of the sub-intervals;

multiplying an N-th term of the series expansion with a predetermined second weight for inputs on a right side of the center for said each of the sub-intervals; and

combining the series expansion and the multiplied N-th term with the predetermined first and second weights to obtain an approximation of the input function in said each of the sub-intervals.

9. The method of claim 8, wherein the predetermined first and second weights on the left and right side, respectively, in said each of the sub-intervals are selected to minimize a maximum error between the approximation of the input function with the finite number of terms N and a nominal value of the input function over all inputs in corresponding sub-intervals.

10. A method for compensating a carrier frequency offset in an orthogonal frequency division multiplexing (OFDM) system, comprising:

estimating the carrier frequency offset $\hat{\varepsilon}$ by using a series expansion of an arctangent function arctan(x);

using the estimated carrier frequency offset to obtain a phase rotation value for a first input

sample of k=1, wherein $\sin(2\pi\hat{e})$ and $\cos(2\pi\hat{e})$ are series-expanded to minimize an approximation error;

using a phase rotation value for a previous input sample including k=1 to obtain a phase rotation value for a subsequent input sample; and

compensating the phase rotation values for all input samples.

11. The method of claim 10, wherein the estimated carrier frequency offset $\hat{\varepsilon}$ is represented by $\hat{\varepsilon} = \frac{1}{2\pi}\arctan\left\{\frac{\sum_{i=1}^{L}\mathrm{Im}(y(-i)y^*(L-i))}{\sum_{i=1}^{L}\mathrm{Re}(y(-i)y^*(L-i))}\right\}$, where Re and Im represent a real part and an imaginary part, respectively, of a complex number, y(i) represents an i-th received sample, L is a fast fourier transformation (FFT) size, and $\hat{\varepsilon}$ is an estimated and normalized carrier frequency offset of $\Delta\hat{f}T$.

12. The method of claim 11, wherein the phase rotation value for a k-th sample is calculated by:

$$For \quad k=1, \;\; \cos(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n\frac{\Delta\hat{\omega}T_s^{\,2n}}{(2n)!}$$

$$\sin(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n\frac{\Delta\hat{\omega}T_s^{\,(2n+1)}}{(2n+1)!}$$

$$\begin{aligned}For \quad k\geq 2, \;\; \cos(k\Delta\hat{\omega}T_s)&=\cos((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s)\\&=\cos((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)-\sin((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s)\\ \sin(k\Delta\hat{\omega}T_s)&=\sin((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s)\\&=\sin((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)+\cos((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s)\end{aligned}$$

13. The method of claim 10, wherein the phase rotation value for a k-th sample is calculated by:

$$For \quad k=1, \quad \cos(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}{T_s}^{2n}}{(2n)!}$$

$$\sin(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}{T_s}^{(2n+1)}}{(2n+1)!}$$

$$\begin{aligned} For \quad k\geq 2, \quad \cos(k\Delta\hat{\omega}T_s) &= \cos((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \cos((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)-\sin((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \\ \sin(k\Delta\hat{\omega}T_s) &= \sin((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \sin((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)+\cos((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \end{aligned}$$

14. An approximation system for a series expansion of an input function with a finite number of terms N to minimize an approximation error, comprising:

an operational processing unit which expands the input function in Taylor series up to an (N-1)-th term to obtain a first expansion result, expands the input function in Taylor series up to an N-th term to obtain a second expansion result, multiplies the first expansion result by a predetermined weight α to obtain a multiplication result, combines the multiplication result and the second expansion result to obtain a combined result, and divides the combined result by $(\alpha+1)$.

15. The system of claim 14, wherein α is greater than 0 and no greater than 1.

16. The system of claim 14, wherein α obtained for a corresponding respective N is selected so as to minimize a maximum approximation error.

17. An approximation system for a series expansion of an input function with a finite number of terms N to minimize an approximation error, comprising:

an operational processing unit which expands the input function in Taylor series up to an (N-1)-th term to obtain an expansion result, multiplies an N-th term of the expansion result by a predetermined weight value to obtain a multiplication result, and combines the expansion result and the multiplication result to obtain an approximation function f for the series expansion function.

18. The system of claim 17, wherein the predetermined weight value is $\frac{(-1)^N}{(\alpha+1)}$ for $0<\alpha\leq 1$.

19. The system of claim 18, wherein α obtained for corresponding respective N is selected to minimize a maximum approximation error.

20. The system of claim 19, wherein α is obtained by:

(a) selecting a minimum input in a given input x area;

(b) calculating the approximation function f for the input function with the finite number of terms N

(c) obtaining and storing an error $E_{N,x}$ by subtracting approximation function f from a nominal function value of the input x;

(d) determining whether the input x has reached a maximum value in the given input x area, adding a predetermined increment ξ to x when x has not yet reached the maximum value, and repeating steps (b), (c) and (d);

(e) selecting a maximum error value among all the stored errors $E_{N,x}$ for all inputs when x has reached a maximum value; and

(f) searching α to minimize the maximum error value, and storing α as the weight value for a corresponding N.

21. The system of claim 17, wherein α obtained for corresponding respective N is selected to minimize a maximum approximation error.

22. An orthogonal frequency division multiplexing (OFDM) system for compensating a carrier frequency offset, comprising:

an estimator for estimating the carrier frequency offset $\hat{e}$ by using a series expansion of a function arctan(x);

a first phase rotation calculator for using the estimated carrier frequency offset to obtain a phase rotation value for a first input sample of k=1, wherein $\sin(2\pi\hat{e})$ and $\cos(2\pi\hat{e})$ are series-expanded to minimize an approximation error;

a second phase rotation calculator for using a phase rotation value for a previous input sample including k=1 to obtain a phase rotation value for a subsequent input sample; and

a compensator for compensating the phase rotation values for all input samples.

23. The system of claim 22, wherein the estimated carrier frequency offset $\hat{e}$ is represented by $\hat{\varepsilon} = \frac{1}{2\pi}\arctan\left\{\frac{\sum_{i=1}^{L}\mathrm{Im}(y(-i)y^*(L-i))}{\sum_{i=1}^{L}\mathrm{Re}(y(-i)y^*(L-i))}\right\}$, where Re and Im represent a real part and an imaginary part, respectively, of a complex number, y(i) represents an i-th received sample, L is a fast fourier transformation (FFT) size, and $\hat{e}$ is an estimated and normalized carrier frequency offset of $\Delta\hat{f}T$.

24. The method of claim 23, wherein the phase rotation value for a k-th sample is calculated by

$$For \quad k=1, \quad \cos(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}T_s^{\,2n}}{(2n)!}$$

$$\sin(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}T_s^{\,(2n+1)}}{(2n+1)!}$$

$$\begin{aligned} For \quad k\geq 2, \quad \cos(k\Delta\hat{\omega}T_s) &= \cos((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \cos((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)-\sin((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \\ \sin(k\Delta\hat{\omega}T_s) &= \sin((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \sin((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)+\cos((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \end{aligned}$$

25. The method of claim 22, wherein the phase rotation value for a k-th sample is calculated by

$$For \quad k=1, \quad \cos(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}T_s^{\,2n}}{(2n)!}$$

$$\sin(\Delta\hat{\omega}T_s)=\sum_{n=0}^{N}(-1)^n \frac{\Delta\hat{\omega}T_s^{\,(2n+1)}}{(2n+1)!}$$

$$\begin{aligned} For \quad k\geq 2, \quad \cos(k\Delta\hat{\omega}T_s) &= \cos((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \cos((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)-\sin((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \\ \sin(k\Delta\hat{\omega}T_s) &= \sin((k-1)\Delta\hat{\omega}T_s+\Delta\hat{\omega}T_s) \\ &= \sin((k-1)\Delta\hat{\omega}T_s)\cos(\Delta\hat{\omega}T_s)+\cos((k-1)\Delta\hat{\omega}T_s)\sin(\Delta\hat{\omega}T_s) \end{aligned}$$